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EXPERIMENTAL STUDY ON PARTIAL REPLACEMENT OF FINE AGGREGATE WITH QUARRY DUST AND SAW DUST

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Abstract-***The fine aggregate is one of the predominant contents of concrete usually natural river sand is using as the fine aggregate. Scarcity of good quality natural river sand due to depletion of resources and restriction due to environmental consideration, to make concrete manufacturing to look for suitable alternative fine aggregate.This project deals with experimental study on partial replacement of fine aggregate with quarry dust and saw dust. Quarry dust and saw dust which are the byproducts generated from stone crushers and wood processing work abundantly available all over the regions. Generally the availability of sand becomes a herculean task, especially in Kerala. In preparing concrete fine aggregate is partially replaced by quarry dust and saw dust. The present investigation has been undertaken to study the effect of quarry dust and saw dust, by adding quarry dust of 0%, 10%, 20%, 30% and 40%. And saw dust of 0%, 5%, 10%, 15% and 20% with the fine aggregate, a matured fine aggregate has prepared. The result comprise that the compressive and split tensile strength of adding 30% of quarry dust and 15% saw dust provide a maximum of compressive strength of 36.26N/mm^2 for 28 days and split tensile strength of 3.8N/mm^2 for 28 days. The fact found in the investigation is the saw dust can be added maximum up to 15% without affecting any of the physical or mechanical properties. An interesting and most significant point found is by increasing the percentage of saw dust, the cost of the whole concrete mixture can be reducedand the weight can be reduced up to 20%.***

Key Words- Quarry dust, Saw dust, Compressive strength, Split tensile strength, Flexural strength

I. INTRODUCTION

Concrete as a composite material the workability for placement and strength development with the age depend upon the constituent materials and their combined action[7]. Concrete is the most popular building material in the world. However, the production of cement has diminished the lime stone reserves in the world and requires a great consumption of energy. Riversand has been the most popular choice for the fine aggregate component of concrete in the past, but over use of the material has led to environmental concerns, the depleting of securable river sand deposits and a concomitant price increase in the material[4]. Cement and concrete production consumes enormous amounts of natural resources and aggregate, their by causing substantial energy and environmental losses[5]. Concrete is that pourable mix of cement, water, sand and gravel that hardens in to a super strong building material. River sand used as fine aggregate in concrete is derived from river banks. River sand has been the most popular choice for the fine aggregate

component of concrete in the past, but over use of the material has led to environmental concerns, the depleting of the river sand deposits and an increase in the price of the material[2]. Seeley (1993) defines sandcrete blocks as walling material that is made of coarse natural sand or crushed rock dust mixed with cement in certain proportion and water, and moderately compact in to shapes [1]. Saw dust is an organic waste resulting from the mechanical milling or processing of timber (wood) in to various shapes and sizes. The dust is usually used as domestic fuel. Resulting ash known as saw dust ash is a form of pozzolana[3]. The development in the construction industry all of the world is progressing. Many structures are being built both residential and non residential. Just like many countries, the demand for new structures in the Philippines is highly increasing. Most building construction works consists of concrete work, there for the reduction in cost of concrete production will reduce the cost of building construction [6].

From the above the following objectives are found out.

- To determine the optimum quantity of river sand to be replaced by Quarry dust and saw dust and to obtain maximum results.
- To compare the strength characteristics of normal concrete and concrete with Quarry dust and Saw dust.
- To achieve economy in construction.

The scopes are

- To study the influence of quarry dust and saw dust o the mechanical properties of concrete.
- To compare the compressive, split tensile strength and the flexural strength using quarry dust and the saw dust with the conventional mix.

II. METHODOLOGY

The methodology clearly shows the process which have been carried out in this work. The step by step process of this project is explained in the flow chart.

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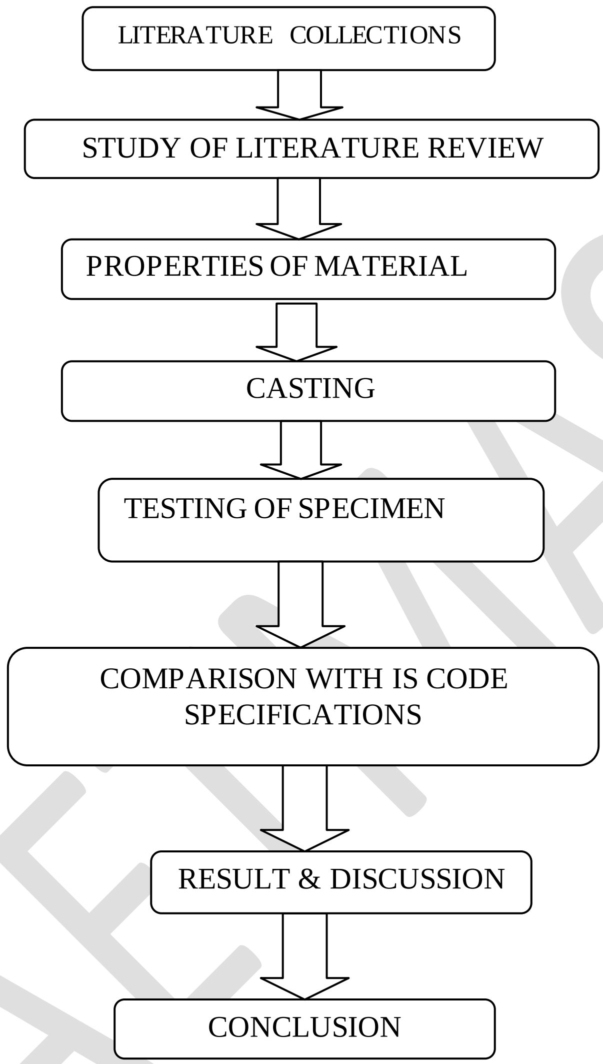

Fig.2.1 Work Methodology

Table 1 Physical properties of material

Properties	Coarse aggregate	Fine aggregate	Quarry dust	Saw dust
Maximum size (mm)	20	4.75	4.75	4.75
Specific gravity	2.69	2.62	2.6	0.27
Absorption (%)	0.5	1	1	2

Mix Proportion

Grade	Cement(kg/m3)	F.A (kg/m3)	C.A(kg/m3)	Water (l/m^3)
M30	352	707.66	1234.71	158
Ratio	1	2.01	3.51	0.45

III. MATERIALS USED

The materials used for this study are given below.

- Cement
- Fine aggregate
- Coarse aggregate
- Quarry dust
- Saw dust
- Admixtures
- Water

PROPERTIES OF THE MATERIAL USED

The cement using Ordinary Portland cement53grade(Ultratech –OPC53). All the properties of cement were determined by referring IS-12269-1987. The specific gravity of cement is 3.15. The initial and final setting times were found as 35 minutes and 420 minutes respectively. Standard consistency of cement as 34%.

Table 2.Physical properties of cement

PHYSICAL PROPERTIES OF ORDINARY PORTLAND CEMENT			
Charecteristics	Unit	Test results	Requirement as per IS 12269- 1987
Setting time • Initial set • Final set	 Minutes Minutes	 35 420	 Min 30.00 Max 600.00
Standard consistency	%	34	
Specific gravity		3.15	

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Fine aggregate is defined as material that will pass 4.75mm sieve and will for the most part, be retained on 75 micron sieve. For increased workability and for economy as reflected by use of less cement, the fine aggregate should have a rounded shape. The purpose of the fine aggregate is to fill the voids in the coarse aggregate and to act as a workability agent.

The coarse aggregates with size 20mm were tested and the specific gravity value of 2.69 and fineness modulus2.36 . Aggregates were available from local sources.Water absorption 0.5%.

Quarry dust is fine rock particles. When boulders are broken into small pieces quarry dust is formed. It is grey in colour and it is like fine aggregate. In concrete production it could be used as a partial or full replacement of natural sand. Besides, the utilization of quarry waste, which itself is a waste material, will reduce the cost of concrete production. Water absorption 1%

Fig.3.1Quarry Dust

Saw dust is a by-product of cutting, grinding , drilling, sanding, or otherwise pulverizing wood with a saw or other tool; it is composed of fine particles of wood. It is also the byproduct of certain animals, birds and insects which live in wood, such as the woodpecker and carpenter ant. It can present a hazard in manufacturing industries, especially in terms of its flammability. Saw dust is the main component of particleboard. A major use of saw dust is for particleboard; coarse sawdust may be used for wood pulp. Water absorption 2%and pH 8.

Fig.3.2Saw Dust

Super plasticizer is the high range water reducing admixture. The super plasticizer should be constantly or intermittently in contact with water. Master RheobuildSSSS 924KL is a liquid admixture

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for concrete to achieve high resistance to water ingress. It significantly improveing the site mixed and precast concrete without increasing water demand. Minimizes segregation and bleeding and improve pumpability. Major increases in strength at early ages without increases the cement content.

Table 3.Physical properties of Admixure

Particularly suitable for all structural concrete with advantages of improved workability, increased strength, improved quality, higher cohesion and also chloride free.

Sl No:	Particulars	Value/Description (as per manufacturer)
1	Aspect	Dark brown free flowing liquid
2	Relative density	1.22 ± 0.02 at 25 ^{o} C
3	pH	≥6 at 25 ^{o} C
4	Chloride ion Content	≤ 0.2%

Fig.3.3.Admixture

IV. TEST PROGRAM

In this experimental study, the test was conducted for M30 mix containing Quarry dust ranging from 0,10%, 20%,30%,40% combined with Saw dust ranging from 0,5%,10%,15% &20% remaining percentage river sand is used.The slump was measured using slump cone apparatus and the slump was found from 120 to 135mm for normal mix and 110 to 120mm for quarry dust and saw dust concrete. The slump values indicate that the wokability of quarry dust and saw dust concrete is more or less equal to controlled concrete.Compressive strength of concrete is determined as per IS:516-1959. The compressive strength of concrete ie., ultimate strength of concrete is defined as the load which causes failure of the specimen divided by the area of the cross section in uniaxial compression, under a given rate of loading. To avoid large variation in the results of compression test, a great care is taken during the casting of the test specimen and loading as well. It is however realized that in the structure, the concrete at any point is in a complex stress condition and not in uniaxial compression only. Concrete under tri-axial state can offer more resistance and will fail only after considerably large deformations. The 150mm cubes have

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been made as per I.S code practice. The advantage of selection of IS 516-1959 cubes as the standard test specimen is that two plane and parallel surfaces can always be found between which the load can be applied. Compression testing machine is used to test the concrete cubes. The compression strength is calculate using the formula,

$$\text{Compressive strength} = \frac{Peak\ Load}{\text{Contact area of the cube}}$$

At each desired curing periods specimens were taken out of water and kept for surface drying. The cubes were tested in 200T capacity compressive testing machine to get the compressive strength of concrete.

Split tensile strength is one of the basic and important properties of concrete. A knowledge of its value is required for the design of concrete structural elements subjected to transverse shear, torsion, shrinkage and temperature effects. Its value is also used in the design of prestressed concrete structures, liquid retaining structure, roadways and runways slabs, etc. Direct tensile strength of concrete is difficult to determine; recourses is often taken to the determination of flexural strength or the splitting tensile strength and computing the direct tensile strength. The usefulness of the splitting cylinder test for assessing the tensile strength of concrete in the laboratory is widely accepted.

$$\text{Splitting tensile strength} = \frac{2P}{\pi DL} \text{N/mm}^2$$

P is the failure load; D the diameter and L is length of the specimen.When concrete is subjected to bending, tensile and compressive stresses and in many cases, direct shear stresses are developed. The most common plain concrete subjected to flexure is a highway pavement and the strength concrete for pavement is commonly evaluated by means of bending test. Flexure test is intended to give the flexural strength of concrete in tension. The flexural strength test is easily carried out and is more convenient than the crushing test to use in the field, since in this test only much smaller loads are required.

The flexural strength of the specimen shall be expressed as the modulus of rupture and shall be calculated to the nearest 0.05N/mm2

$f_{ct}=Pl/bd^2$……………………………..(1)

$f_{ct}=3Pa/bd^2$…………………………..(2)

a = distance between line of fracture and the nearer support, measured along the center line of the tension side of the specimen.

'b' is the measured width of the specimen in mm 'd' is the measured height of the specimen in mm at the point of failure, 'l' is the length in mm of the span on which the specimen was supported and 'P' is the maximum load in N(kg) applied on the specimen.

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When a>200mm for 150mm specimen and a>133 mm for 100mm specimen, equation (1) can be used to calculate the modulus of ruptureWhen 170<a<200mm for 150mm specimen and 110<a<133mm for 100mm specimen equation (2) can be used to calculate the modulus of rupture.

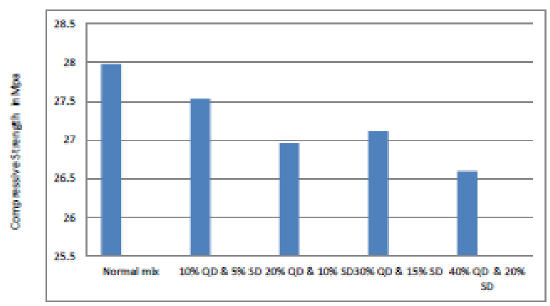
When a<170mm for 150mm specimen and a<110mm for 100mm specimen, the result of the test shall be discarded.

TEST RESULTS FOR HARDENED CONCRETE

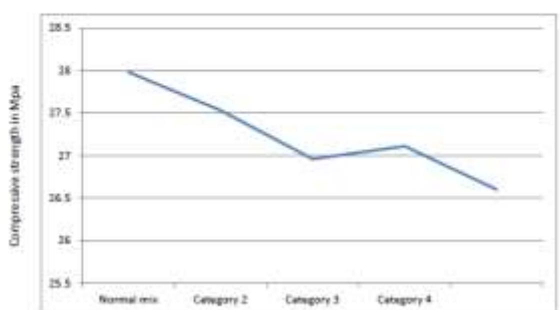
COMPRESSIVE STRENGTH TEST RESULTS

Table 4. Compressive strength results for 7 & 28th days

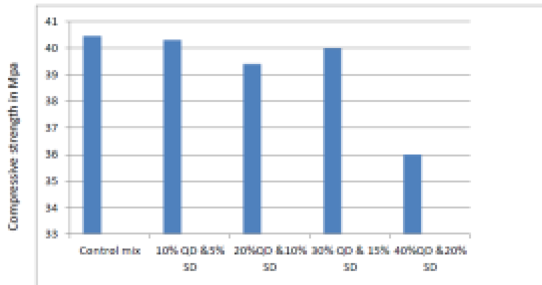
	Casting date	Weight in kg	7th day test(N/mm^2)	28th day test(N/mm^2)
Control mix	16/03/16	8.97	27.98	40.44
Replacement 10% Quarry dust (QD) 5% saw dust (SD)	17/03/16	8.1	27.53	40.29
20% QD 10%SD	21/03/16	7.5	26.96	39.40
30%QD 15%SD	23/03/16	7.3	27.11	40.00
40%QD 20%SD	03/04/16	6.9	25.48	35.26



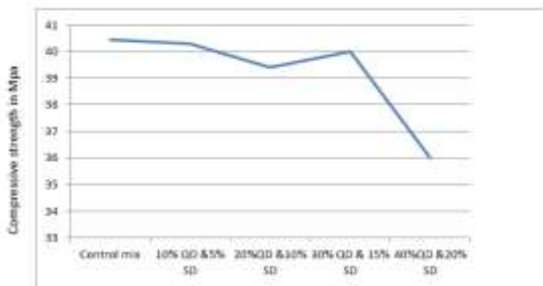
7th day Compressive strength



7th day Compressive strength result



28th day Compressive strength



28th day Compressive strength result

Table 4 gives the 7th and 28th day compressive strength test results conducted for control mix and replacement of fine aggregate with different percentage of quarry dust and saw dust. The bar chart indicates that the better result obtained with an optimum percentage of 30% and 15% by quarry dust and saw dust respectively.

SPLIT TENSILE STRENGTH RESULTS

Table 5. Split tensile strength results for 7 & 28th days

	Casting date	Weight in kg	7th day test(N/mm²)	28th day test (N/mm²)
Control mix	16/03/16	13.3	3.57	4.37
Replacement 10% Quarry dust (QD) 5% saw dust (SD)	17/03/16	12.6	3.48	4.24
20% QD 10%SD	21/03/16	12.4	3.20	3.90
30%QD 15%SD	23/03/16	12.3	3.45	4.00
40%QD 20%SD	03/04/16	11.2	2.97	3.82

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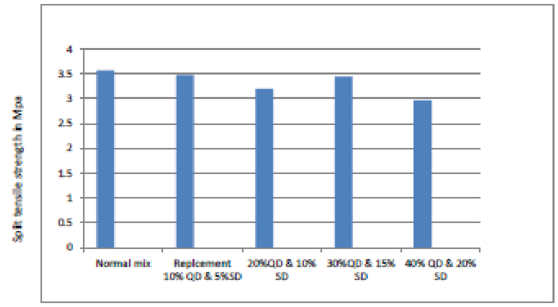
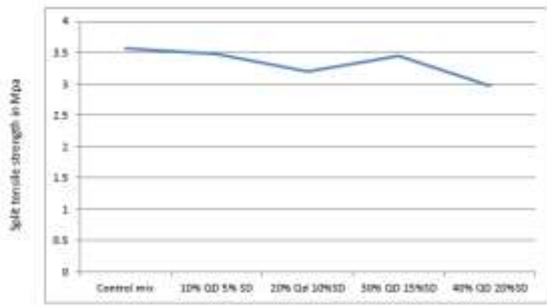
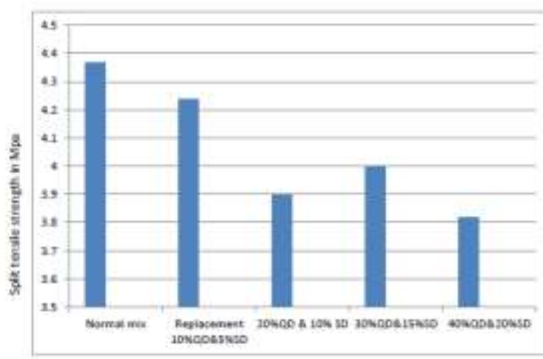


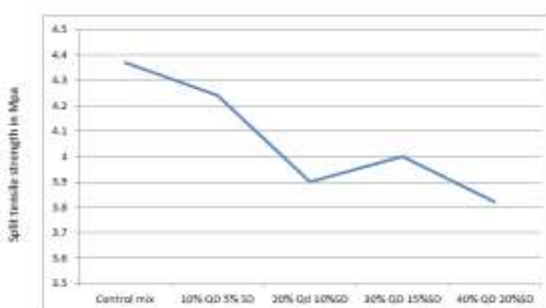
7th day Split tensile strength



7th day Split tensile strength result



28th day Split tensile strength



28th day Split tensile strength result

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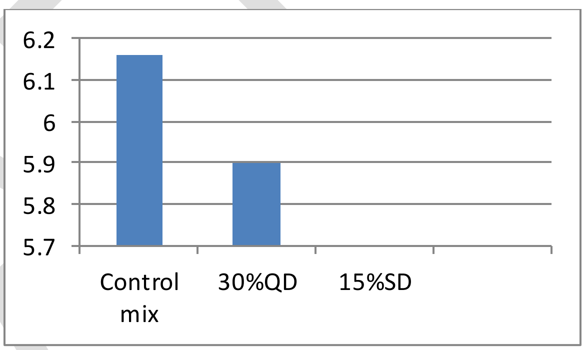
From the above table 5 indicates the results it was observed that the split tensile strength is obtained for mix 30% quarry dust and 15% saw dust replacement at the water cement ratio 0.45. The above result clearly indicates that the split tensile strength decreases up to 20% by quarry dust and 10% saw dust but it increases by replacement of 30% by quarry dust and 15% by saw dust.

FLEXURAL STRENGTH RESULTS

Table 6. Flexural strength results for 7 & 28th days

7th day Flexural strength

	Casting date	Weight in kg	7th day test (N/mm^2)	28th day test(N/mm^2)
Control mix	16/03/16	12.9	6.16	7.50
30%QD 15%SD	23/03/16	11.3	5.9	6.90



7th day Flexural strength result

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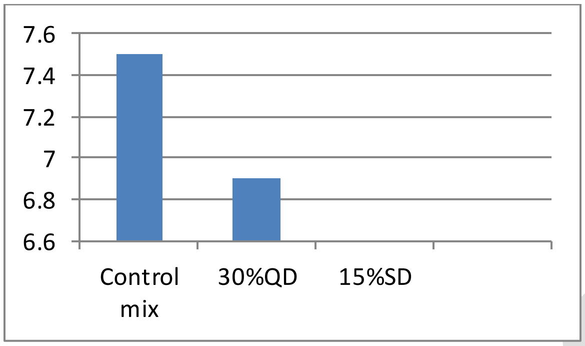
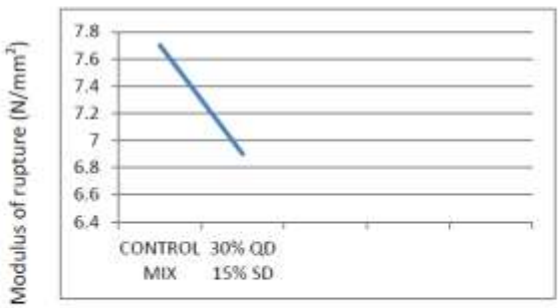


28th day Flexural strength



28th day Flexural strength result

Flexural strength test was conducted on specimen 100x100x500, both control concrete and replacement 30% quarry dust and 15 % saw dust. The test result are given in table 6. Flexural strength of quarry dust and saw dust mix was observed to marginally lesser than the control concrete.

V. CONCLUSION

The following conclusions could be arrived from this experimental study.

The compressive strength of quarry dust and saw dust upto 30% and 15% respectively is almost similar to that of control mix.

Split tensile strength of quarry dust and saw dust upto 30% and 15% respectively is almost similar to that of control mix.

Two-point loading test result shows that the first crack load is almost same for both control mix and quarry dust and saw dust concrete.

Quarry dust and saw dust content of 30% and 15% by weight of has shown the best results. Thus indicating the possibility of using quarry dust and saw dust as a partial replacement of fine aggregate up to this level.

The weight can be reduced upto 20%.

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